Canada's nuclear fuel
industry

Background Paper

BP-360E

CANADA'S NUCLEAR FUEL INDUSTRY: AN OVERVIEW

Alan Nixon
Science and Technology Division

November 1993

Library of Parliament
Bibliothèque du Parlement

Research Branch

The Research Branch of the Library of Parliament works exclusively for Parliament, conducting research and providing information for Committees and Members of the Senate and the House of Commons. This service is extended without partisan bias in such forms as Reports, Background Papers and Issue Reviews. Research Officers in the Branch are also available for personal consultation in their respective fields of expertise.

Available in Canada through
your local bookseller
or by mail from
Canada Communication Group -- Publishing
Ottawa, Canada K1A 0S9

Catalogue No. YM32-2/360E
ISBN 0-660-15635-0

CE DOCUMENT EST AUSSI
PUBLIÉ EN FRANÇAIS

TABLE OF CONTENTS

Page

CANADA
LIBRARY OF PARLIAMENT
BIBLIOTHÈQUE DU PARLEMENT

CANADA'S NUCLEAR FUEL INDUSTRY: AN OVERVIEW

INTRODUCTION

On 2 December 1942, the world's first nuclear reactor "went critical," that is, the nuclear chain reaction became self-sustaining, and the nuclear age was born. The experiment, carried out on the campus of the University of Chicago and led by Enrico Fermi, was a crucial step toward the development of both nuclear weapons and, somewhat later, nuclear power.

Nuclear fission was discovered by European scientists shortly before the Second World War. From the beginning, the potential of fission as a source of energy and as the basis of a weapon of unprecedented destructive power was appreciated. Initially, however, it was the military applications that motivated the pursuit of nuclear technology. During the Second World War and for a number of years after, the main focus of nuclear programs was the development of nuclear weapons.

Shortly after the Second World War, interest turned to peaceful applications of nuclear technology for the generation of electricity. Nuclear power was embraced with high expectations. It appeared to offer the prospect of a new, cheap, abundant source of energy with the potential to enhance world prosperity. Initially it was widely believed that uranium, like coal and oil, was simply another source of energy that could be harnessed by largely conventional technology. Nuclear energy was widely viewed as the only practical way of meeting a demand for energy that had increased rapidly since the end of the Second World War; through the mid-1960s to mid-1970s utilities, especially in the United States, placed numerous orders for nuclear reactors.

Those early expectations have now faded as the nuclear power industry around the world has stagnated and is facing an uncertain future. There are a number of reasons for

the decline in fortune. These include escalating costs, increasing regulatory requirements, and continuing public concern over safety and waste disposal. As a result, orders for new nuclear power stations around the world have been either cancelled or delayed. As of August 1992, the number of nuclear power stations cancelled, indefinitely deferred or suspended exceeded the number of stations planned or under construction by a margin of almost two to one.[(1)] For the most part, nuclear power development programs around the world have been put on hold and only a few countries, like Japan and South Korea, remain committed to building significant numbers of new nuclear power stations.[(2)]

The result has been that potential domestic and export markets for new nuclear plants have shrunk very markedly and competition for the export of nuclear technology to the few remaining countries with active nuclear programs has been intense. Because of an oversupply of nuclear fuels, the price of uranium has plummeted since the late 1970s.

In some ways, Canada's nuclear industry is a microcosm of the world nuclear industry. Ontario, Canada's largest consumer of nuclear power, currently has a large surplus of electrical capacity. Ontario's latest nuclear installation at Darlington has cost an estimated $13.8 billion, almost 90% more than originally planned.[(3)] Older nuclear installations have experienced technical problems that might curtail their planned lives or necessitate costly repairs or overhauls. No new domestic orders for nuclear power stations have been placed since 1974 and, until the sales of CANDU reactors to South Korea in 1900 and 1992, there had been no export sales of reactors since 1985, when Atomic Energy of Canada Limited (AECL) last sold a reactor to Romania.[(4)] In other respects, however, Canada's nuclear industry is distinct. Canada has developed its own indigenous line of nuclear reactors in the CANDU and is the western world's largest producer and exporter of uranium.

---

(1) *World Nuclear Industry Handbook 1993,* Nuclear Engineering International, Sutton, England, 1993, p. 10, 26-49.

(2) *Ibid.*, p. 10.

(3) Geoff McCaffrey, Manager CANDU Communications, AECL, personal communication/unpublished background on Darlington costs.

(4) *World Nuclear Industry Handbook 1993*, p. 37.

Now, half a century since Enrico Fermi conducted that first demonstration of a controlled nuclear chain reaction at the University of Chicago, is perhaps an appropriate time to review the situation of the nuclear power industry and to ask what the future might and should hold. This background paper, one of a series examining various aspects of nuclear power both in the Canadian and the broader global contexts, will review the Canadian nuclear fuels industry.

THE BEGINNING OF THE CANADIAN URANIUM INDUSTRY

Canada was among the first countries to mine and process uranium-bearing ores. Such ores contain trace amounts of radium, which was in great demand for medical treatment and for use by research laboratories in the early part of the century. At the height of the demand, radium sold for the equivalent of several million dollars an ounce. Uranium, which had only limited uses, primarily in the ceramics industry, was essentially a by-product of radium production.

In 1930, one of the world's richest uranium deposits was discovered by Gilbert LaBine on the shore of Great Bear Lake in the North West Territories.[5] The deposit was developed for its radium content by Eldorado Gold Mines Limited, a company formed several years earlier by Gilbert and his brother Charles to develop a gold claim in Manitoba.

Concentrate from the mine at Great Bear Lake was shipped across Canada to a refinery built in Port Hope, Ontario, where the radium and uranium were extracted. At the time, the Port Hope refinery may have been the largest of its kind in the world.[6] It was the only one in North America, and one of only two in the world that could refine uranium.[7] Canada and Eldorado were thus in a unique position at the outset of the Second World War when uranium was needed for the Manhattan project.

---

(5) Earle Gray, *The Great Uranium Cartel,* McClelland and Stewart, Toronto, 1982, p. 19.

(6) Wilfred Eggleston, *Canada's Nuclear Story,* Harrap Research Publications, London, 1966, p. 20.

(7) Gray (1982), p. 28.

In the spring of 1941, the U.S. placed an initial order for refined uranium oxide with Eldorado[8] and, by the end of that year, U.S. contracts for uranium had committed Eldorado's entire production until almost the end of 1945.[9] Eldorado already had a stockpile of several hundred tonnes of uranium concentrates accumulated on the site of its Port Hope refinery. In addition, Eldorado also processed African uranium ore from the Belgian Congo which the U.S. had purchased from the Belgian company, Union Minière.[10] In 1942, Eldorado reopened the mine at Great Bear Lake, which had been shut down in 1940 because of falling demand for radium.[11]

After the war, the mine at Great Bear Lake continued to operate until 1960, when the deposit was finally exhausted.[12] By this time, Canada had a thriving uranium mining industry with mines at Beaverlodge, north of Lake Athabasca; in the Elliot Lake area of Ontario; and at Bancroft, Ontario. The boom that had been created by the nuclear weapons industry was about to end, however. In 1959, the U.S. Atomic Energy Commission announced that it would not exercise its options to purchase additional Canadian uranium and thereafter the industry went into a decline. Its bare survival of the ensuing slump was thanks in large measure to a Canadian government stockpiling program. It would not be until 1986 that production matched the level achieved in 1960.[13][14]

---

(8) Eggleston (1966), p. 44.

(9) Gray (1982), p. 29

(10) *Ibid.*, p. 29.

(11) *Ibid.*, p. 19-29.

(12) *Ibid.*, p. 33.

(13) *1970-71 Canada Yearbook,* Dominion Bureau of Statistics, Information Canada, Ottawa, 1971, p. 702.

(14) *1992 Canada Yearbook,* Statistics Canada, Minister of Industry, Science and Technology, 1991, p. 412.

NUCLEAR FUEL PRODUCTION

A. Ore to Fuel

For the last half century, the same basic processes have been used to extract uranium from its ores and convert it to a form suitable for use in nuclear reactors. The process described here is that currently in use in Canada.

Mining can take a variety of forms, from open-pit to deep, hard-rock. Mining is typically the most costly step in the process, particularly for lower-grade ores. The ore is crushed and ground in the mill to the consistency of fine sand from which the uranium is extracted chemically to produce the impure concentrate known as "yellowcake." The mill is usually located close to the mine to avoid hauling the ore over long distances. After the uranium is extracted, the bulk of the ore remains as the mineral residue known as "tailings"; these are slightly radioactive, due to the presence of other naturally occurring radionuclides such as radium and thorium.

In the next step, the impure uranium concentrate is chemically refined into highly purified, nuclear-grade, uranium trioxide (UO_3). Uranium trioxide is then converted, in two separate chemical processes, into uranium dioxide (UO_2), which is destined for domestic consumption, and uranium hexafluoride (UF_6), which is exported.

In Canada, fabrication is the final step of the fuel production process. Uranium dioxide powder is compressed and sintered into very dense "ceramic" pellets which are then sealed in zirconium tubes and assembled into fuel bundles for CANDU reactors. Since CANDU reactors do not require enriched uranium, the uranium is "natural" in the sense that it contains the naturally occurring concentration of the fissionable isotope ^{235}U.

Almost all other reactor types in use around the world require slightly enriched uranium, for which uranium hexafluoride is used as the feed. After enrichment, the UF_6 must still be converted back to a form suitable for reactor use. Enrichment also generates a considerable quantity of depleted uranium which contains a lower than natural concentration of ^{235}U. Depleted uranium has very limited uses but the fact that these include both conventional and nuclear armaments has caused concern and controversy. All of the UF_6 produced in Canada

is exported as Canada has neither enrichment facilities nor the light-water reactors that require enriched uranium as fuel.

One of the interesting features of its production is that uranium is normally purchased by electric utilities in the form of concentrate from the mining companies. The utilities then contract with other processors for refining, conversion, enrichment, and fabrication services to produce the finished fuel.

B. Mining and Milling

1. Distribution of Uranium Deposits

Although deposits of uranium are found in a number of areas of Canada, the Athabasca Basin of northern Saskatchewan and the Elliot Lake area of Ontario are by far the largest known and are currently the only areas producing uranium. About half the known reserves are located in Saskatchewan and somewhat less than half are in Ontario.(15) Total recoverable uranium resources are estimated to be about 450 kilotonnes (kt).(16)(17) Most of Canada's uranium is now produced in Saskatchewan with the share produced in Ontario rapidly decreasing.

Production is summarized in Figure 1.

2. Uranium Mining in Saskatchewan

Saskatchewan now dominates Canadian uranium production with the Athabasca basin in the north of the province the site of some of the world's richest deposits of uranium. Cigar Lake, for example, is believed to be the largest high-grade uranium deposit in the world; it has reserves of almost 150,000 tonnes of uranium (tU) at an average grade of 9% uranium

---

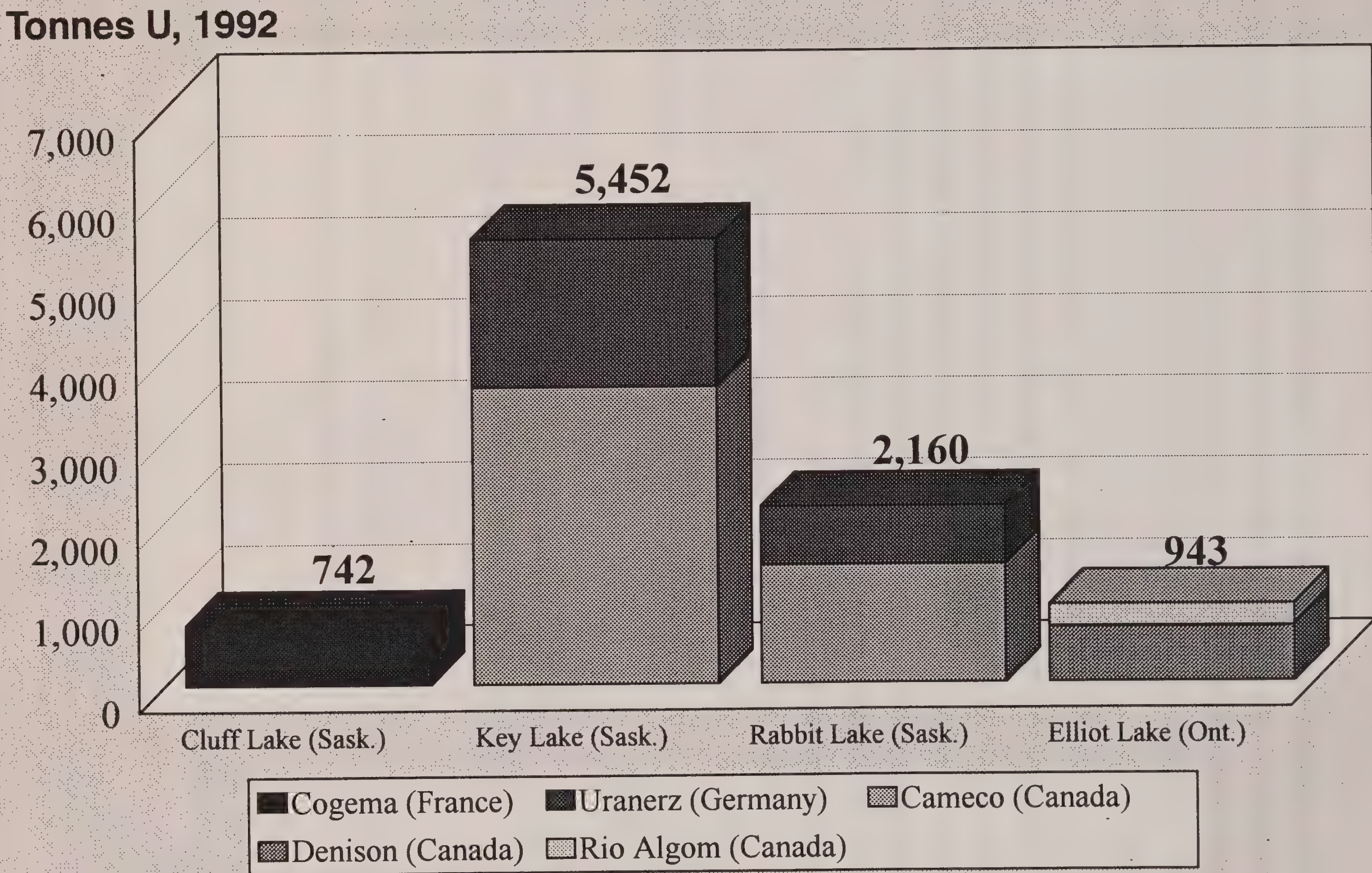
(15) Southam Energy Group, *Energy in Canada 1990-1991*, Debbie Thomas (ed.), Southam Energy Group, Don Mills, Ontario, 1990, p. 194.

(16) R. Whillans, *Annual Assessment of Canada's Uranium Supply Capabilities*, Energy Mines and Resources, Ottawa, 1 January 1993, p. 5.

(17) Resources estimated at prices of $150/kg U or less.

FIGURE 1

Production of Uranium in Canada



Source: R. Whillans, *Annual Assessment of Canada's Uranium Supply Capabilities*, Natural Resources Canada, 1 January 1993, p. 5.

(U).[18] Although the deposit is smaller, some remarkably high grades of up to 65% U have been reported at the McArthur River.[19] Some high-grade ores will require the development of specialized mining methods in order to avoid exposing miners to high levels of radiation. Cameco is already using remotely controlled equipment at the Eagle Point test mine at Rabbit Lake.[20]

As mining and milling account for a major part of the cost of producing concentrate, Saskatchewan ores, with average grades of 1-2% U, can be processed much more economically than the low-grade Ontario ores with less than 0.1% U. There are currently three operational mine/mill facilities in the Athabasca region: Key Lake, Rabbit Lake, and Cluff Lake. The combined capacity is almost 13,600 tU/year[21] but recent production has been well below capacity.[22] The uranium production workforce in Saskatchewan is quite small; from 1989 to 1991, it numbered around 700.[23][24]

Saskatchewan's currently operating mines will be exhausted sometime between the mid-1990s and early next century.[25] There is, however, a great deal of potential for the development of new high-grade ore bodies that could extend uranium mining operations for several decades.

On the other hand, uranium mining has been controversial in Saskatchewan and there has been considerable public debate over the expansion and even continuation of the industry. Until recently, the Saskatchewan New Democratic Party had favoured a phase-out of

---

(18) Cameco Corporation, *1992 Annual Report*, Saskatoon, Saskatchewan, 1993, p. 23.

(19) *1991 Canadian Minerals Yearbook*, Energy, Mines and Resources, Ottawa, 1992, p. 50.6.

(20) Cameco Corporation, *1992 Annual Report*, p. 13.

(21) Atomic Energy Control Board, *Annual Report 1991-1992*, Minister of Supply and Services Canada, Ottawa, 1992, p. 37.

(22) Whillans (1993), p. 5.

(23) *1991 Canadian Minerals Yearbook*, p. 50.13.

(24) *1992 Canadian Minerals Yearbook*, Energy, Mines and Resources, Ottawa, 1993, p. 53.15.

(25) R.T. Whillans, Energy, Mines and Resources, personal communication, 25 May 1993.

the uranium mining industry but, at its November 1992 annual convention, the party reversed the nine-year-old policy that would have placed a moratorium on uranium exploration and would have phased out existing mines.[26] This issue has caused significant dissent within the party.

In April 1991, six new mines were referred for public review under the federal government's Environmental Assessment and Review Process Guidelines. One of these, the expansion of Cameco's Rabbit Lake operation, has already received conditional approval from Saskatchewan and has now been reviewed by a federal panel which is expected to make its recommendation in the fall of 1993.[27]

A report of the joint panel on three of the other projects was released in October 1993. The panel recommended that one of the projects, the extension of the Dominique-Janine mine at Cluff Lake, should be allowed to go ahead subject to a number of conditions; that the Midwest Joint venture should not be permitted; and, that the McClean Lake project should be delayed for at least five years, in part to provide time to allow an evaluation of the tailings system at Rabbit Lake.[28]

3. Uranium Mining in Ontario

Low ore grades, high production costs, and a depressed market have hastened the demise of uranium mining in Ontario. Long-term contracts with Ontario Hydro that provided stability to the area's producers have either already run out or are being accelerated. Of eleven mines once active in the Elliot Lake area of northern Ontario, only one, Rio Algom's Stanleigh, remains in operation and it will close by mid decade.[29]

Ontario's uranium production workforce has historically been much larger than that of Saskatchewan but it is now decreasing rapidly. From 1987 to 1989, it numbered around

---

(26) David Roberts, "Saskatchewan NDP Reverses Uranium Stand," *The Globe and Mail* (Toronto), 9 November 1992, p. A1-A2.

(27) "Rabbit Lake Hearings End," *The Source*, Cameco Corporation, August 1993, p. 1.

(28) *Uranium Mining Developments in Northern Saskatchewan: Dominique-Janine Extension, McClean Lake Project, and Midwest Joint Venture*, Joint Federal-Provincial Panel on Uranium Mining Developments in Northern Saskatchewan, Minister of Supply and Services, October 1993, p. 1.

(29) *1991 Canadian Minerals Yearbook*, p. 50.2.

3,700, but by 1990 it had already been fallen to under 2,000, primarily because of the closing of the Quirke and Panel mines,[30] while in 1992, a further 580 workers were laid off with the closing of the Denison mine.[31] The mine closures and the loss of jobs have had a profound effect on the local economy. Both the Government of Ontario and Ontario Hydro are providing economic support to assist the Elliot Lake area shift its economy from a dependence on uranium to a more diversified base.[32]

4. The Uranium Market

Canada has been the western world's leading producer of uranium concentrates since 1984.[33] In 1991, Canada produced 30% of the western world's uranium, well ahead of its closest rivals, Australia and the U.S, which accounted for 14 and 11% respectively.[34] In 1992, Canada's share increased still further to 40%.[35]

Even though Canada has been the leading producer, production has fallen in recent years. In 1987, it peaked at 13.6 kt worth $1.18 billion but by 1991 it had fallen to 8.2 kt worth valued at only $0.6 billion.[36][37] In 1992, however, production recovered to 9.3 kt although value continued to fall to slightly below $0.6 billion. Despite Canada's position as the leading producer of uranium, that mineral ranks only sixth in leading metals after gold, copper, nickel, zinc, and iron ore[38] and thirteenth in overall mineral production.[39]

---

(30) *Ibid.*, p. 50.13.

(31) "Denison Ends 35-Year Run of Elliot Lake Mining," *Northern Miner,* 16 March 1992, p. 13.

(32) *1991 Canadian Minerals Yearbook,* p. 50.2.

(33) *Energy in Canada 1990-1991*, p. 195.

(34) *1992 Canadian Minerals Yearbook,* p. 53.9.

(35) Whillans (1993), p. 1.

(36) *1991 Canadian Minerals Yearbook,* p 50.13.

(37) Whillans (1993), p. 5.

(38) *1992 Canadian Minerals Yearbook,* p. 1.12.

(39) *Ibid.*, p. 58.16

Domestic consumption currently accounts for about 20% of total production. The remainder is exported, making Canada the major uranium exporter in the western world. Canada's principal customers are the U.S. and Japan, which have accounted for about 45% and 13% respectively of Canada's uranium exports over recent years. Other important customers include France, Germany, South Korea, Sweden, and the U.K.

Uranium is sold both in medium and long-term supply contracts and on the spot market. Historically, the price of uranium in supply contracts, which assure a secure supply to the customer, is significantly higher than spot market prices, although both markets generally show similar trends over an extended period. Over the last decade uranium prices have dropped dramatically; by 1991, the Canadian export price of uranium had dropped to about half of its 1981 price, while over the same period the spot market price dropped by about two thirds.(40)

Virtually all Canadian uranium is currently sold on contract. Since 1989, very little Canadian uranium has been sold on the spot market;(41) for example, since it was formed in 1988, Cameco has not offered uranium for sale on the spot market.(42) Canadian producers have been able to command higher prices for their uranium through long-term contracts in large part because of their credibility as reliable suppliers.

Two factors have been largely responsible for the current low uranium prices: large inventories of uranium which had been stockpiled by the utilities in anticipation of increased electricity demand and, more recently, an increase in uranium exports from the Commonwealth of Independent States (CIS). Since 1985, demand has exceeded supply causing inventories to fall and thus creating an expectation that the uranium market will recover. A recovery has been impeded, however, by a rapid expansion of uranium exports from the CIS between 1988 and 1991.(43) In 1991, the quantity of uranium reaching U.S. and European

---

(40) Cameco Corporation, *1992 Annual Report*, p. 9.

(41) *1991 Canadian Minerals Yearbook*, p. 50.16.

(42) Cameco Corporation, *1991 Annual Report*, Saskatoon, Saskatchewan, 1992, p. 9.

(43) Cameco Corporation, *1992 Annual Report*, p. 8.

markets from the CIS may have exceeded 9,000 tonnes (t), so that the CIS is rivalling Canada as the world's leading uranium exporter.[44]

In 1991, a group of U.S. uranium producers filed an anti-dumping petition against the CIS and in 1992 six republics of the CIS and the U.S. Department of Commerce reached a "suspension" agreement. The agreement blocks shipments of uranium into the U.S. at prices below US$13/pound and imposes import quotas at prices up to US$21/pound.[45] A similar agreement has been reached between the CIS and the Euratom supply agency to limit the imports into the European community. The suspension agreement does not apply, however, to separate agreements to sell highly-enriched uranium to the U.S. Department of Energy.[46] The suspension agreement, if it lasts, should help to stabilize uranium prices to the advantage of low-cost Saskatchewan producers. Nevertheless, it is likely that the CIS will still gain a significant share of western markets.

Another development that should help Canadian producers is that the Canada-U.S. Free Trade Agreement has lifted both Canadian and U.S. restrictions on the export of Canadian uranium to the U.S.[47] This means that the Canadian requirement to upgrade uranium before export will be phased out and Canadian producers should have better access to the U.S. markets.

C. Refining and Conversion

1. Background

Only one Canadian company, Cameco Corporation, refines and converts uranium. Cameco was formed in 1988 by the merger of the federal Crown corporation Eldorado Nuclear, and the provincial Crown corporation Saskatchewan Mining Development Corporation (SMDC), the initial step toward the eventual privatization of the two governments' uranium interests.[48]

---

(44) *1991 Canadian Minerals Yearbook*, p. 50.7.

(45) Allan Robinson, "Cameco Shares Jump," *The Globe and Mail* (Toronto), 21 October 1992, p. B17.

(46) *Ibid.*

(47) Jon R. Johnson and Joel S. Schachter, *The Free Trade Agreement: A Comprehensive Guide*, Canada Law Book Inc., Aurora, Ontario, 1988, p. 71.

(48) *1989 Canadian Minerals Yearbook*, Energy, Mines and Resources, Ottawa, 1990, p. 65.3.

Until recently, Cameco was one of only five major operators in the western world providing uranium refining and conversion services. In November 1992, Sequoyah Fuels Corporation announced that it was ceasing UF_6 production at its plant in Gore, Oklahoma.[49] This leaves the Allied-Signal plant in Metropolis, Illinois, as the only remaining U.S. producer of UF_6. The other two major producers are British Nuclear Fuels Limited, in the U.K., and Comurhex, in France.

2. Plants

Cameco's uranium refinery is located in Blind River, Ontario, on the north shore of Lake Huron, close to the Elliot Lake area. It was built by Eldorado Nuclear in the early 1980s, to replace an older refinery that had operated at the Port Hope site. The Blind River refinery, which began operating in 1983, has capacity of 18,000 tU/year as UO_3, making it the largest uranium refinery in the western world.[50]

From Blind River, the UO_3 is transported by road to Port Hope, Ontario, where the bulk is converted to UF_6 in the "West UF_6" plant, which has a capacity of 10,500 tU/year.[51] It began operation in 1984, replacing the older East UF_6 plant on the Port Hope site. The rest of the UO_3 is converted in the South UO_2 plant to the ceramic grade UO_2 which will be shipped to fabricators of the fuel bundles for use in CANDU reactors. The capacity of the UO_2 plant is 2,500 tUO_2/year.[52]

3. Production

Because of weak markets, production at both the refinery and the conversion plants has been well below capacity in recent years. In 1990 and 1991, the Blind River refinery operated at about half capacity while the combined throughput of UF_6 and UO_2 conversion was

---

(49) "Nuke Panel Seeks Cost, Timetable for Gore Cleanup," *The Daily Oklahoman,* 30 December 1992, p. 19.

(50) *World Nuclear Industry Handbook 1992,* Nuclear Engineering International, Sutton, England, 1992, p. 136.

(51) Cameco Corporation, *1992 Annual Report*, p. 22.

(52) *Ibid.*

two-thirds of capacity.[53] In 1992, Cameco cut back production still further to about one third capacity at the Blind River Plant and to less than half capacity at the conversion plants.[54]

Cameco has also reduced its workforce at both locations to lower operating costs. Between 1989 and 1992, the Port Hope workforce was cut from 280 to 198 while the Blind River workforce was reduced from 127 to 79 over the same period.[55][56] Cameco also closed its specialty metals plant at Port Hope in 1992. The plant had produced mainly depleted uranium metal and depleted uranium castings for use as counterweights and shielding in the aerospace and medical industries.

4. Developments

Canada has had a long-standing policy requiring uranium to be upgraded in this country before export. In principle, the policy provided a captive market for Canadian refining and conversion services, although in practice it was not rigidly enforced. As of 15 December 1991, new export contracts were no longer subject to the further processing requirement but for existing contracts the requirement will remain until 31 December 1995, when it will be eliminated.[57]

The loss of a partially captive market for conversion services should be offset to some extent by the closure of the Sequoyah UF_6 plant, which has a UF_6 production capacity of 9,000 t, equivalent to 42% of the existing U.S. capacity and 17% of western world capacity. This leaves Cameco with 24% of the remaining western world capacity.[58] Unlike uranium exports, which are dominated by sales to the U.S. market, sales of UF_6 conversion services are

---

(53) Cameco Corporation, *1991 Annual Report*, p. 3.

(54) Cameco Corporation, *1992 Annual Report*, p. 22.

(55) *1991 Canadian Minerals Yearbook*, p. 50.9.

(56) Cameco Corporation, *1992 Annual Report*, p. 22.

(57) *1991 Canadian Minerals Yearbook*, p. 50.7.

(58) "Cameco Loses a Competitor," *The Source*, Cameco Corporation, May 1993, p. 1.

more evenly divided between the U.S. (38%), Europe (40%), and Asia (22%).[59] Cameco currently processes about 70% of its own uranium production; most of the remainder is shipped to the U.S. for conversion.[60]

The capacity of the remaining four converters will not be sufficient to meet future western world demand for UF_6. In 1992, demand already slightly exceeded supply, bringing a modest recovery of the spot price for UF_6. The potential supply of both low and highly enriched uranium from Russia, however, creates significant uncertainty.[61] Cameco is cautiously optimistic about the market for its conversion services.

D. Fabrication

In Canada, fabrication of fuel elements is the final step in the production of nuclear fuels. Two Canadian companies fabricate fuel elements, Canadian General Electric Incorporated (CGE) and Zircatec Precision Industries Incorporated. CGE has two plants: one in Toronto where the pellets are made and the other in Peterborough, Ontario, where the fuel bundles are assembled. The plant capacities are 1,050 tU/year and 1,000 tU/year respectively.[62] The Zircatec plant in Port Hope, Ontario, produces both fuel pellets and assembled fuel bundles. It has a capacity of 1,200 tU/year.[63]

Nearly all of the production of the two Canadian fabricators goes to supply Canadian domestic requirements, primarily to Ontario Hydro but also to Hydro Québec and New Brunswick Power Corporation. Although the fabricators process some export contracts, the export market for fabrication services is small and unreliable since most countries with nuclear facilities have their own fabrication plants.

---

(59) Cameco Corporation, *1992 Annual Report*, p. 8.

(60) Cameco Corporation, *1991 Annual Report*, p. 13.

(61) "Cameco Loses a Competitor," p. 1.

(62) Atomic Energy Control Board, *Annual Report 1991-1992*, p. 39.

(63) *World Nuclear Industry Handbook 1993*, p. 140.

Precise production and workforce figures for the fabricators are not available; however, both are currently operating at significantly less than their maximum capacities. In the short term, the workforce is probably fairly stable. Zircatec's workforce is not expected to change significantly in the foreseeable future.(64) Over the long term, however, the trend has been to increase production with a smaller workforce because of the drive for improved cost-efficiency and technological changes that have improved quality and made the fabrication process less labour-intensive.(65)

OUTLOOK

Although Canada is the leading western world producer and exporter, uranium accounts for only 1.6% of the value of domestic mineral production (including oil and gas). The industry is nevertheless important in terms of exports and particularly to the economies of the areas where uranium is produced and processed.

Over recent years, production and employment have fallen and revenues have decreased; however, there are now some encouraging signs that the industry may be on the verge of a modest recovery. Although there are no immediate prospects for the expansion of nuclear power in Canada, domestic requirements should continue to provide a stable core demand for nuclear fuels for the foreseeable future. Saskatchewan's high grade-ores enable Canadian producers to be very competitive on world markets and should enable Canada to maintain its position as a leading world supplier of uranium Unfortunately, even though it will be controlled, the supply of uranium from the CIS will tend to prevent a major recovery of uranium prices in the near future.

Canada's only refiner and converter of uranium, Cameco, has significantly streamlined its operations in order to become more competitive. Although the further processing requirement for uranium is being phased out, the loss of conversion capacity in the U.S. and

---

(64) Martin Wash, Marketing Manager, Zircatec Precision Industries Inc., personal communication, 28 September 1993.

(65) Wayne Flood, Fuel Sales and Marketing, General Electric Canada Inc., Nuclear Products Section, personal communication, 30 September 1993.

Canada's proximity to U.S. market place Canada in a strong position to compete for the sale of refining and conversion services.

The Canadian uranium mining and processing industry has had a long and interesting history and in a modest but significant way has become part of the cultural fabric of the country. Despite its current position as a world-leader, the industry is unlikely ever to relive its early days, when it played a role close to the centre stage of world affairs. In the present day it continues to evolve and adapt to changing circumstances both within Canada and abroad. In the short term its fate appears relatively secure, though this will ultimately depend on the still unresolved issue of the long-term future of nuclear power.

ACCO®

ACCOPRESS™MC

YELLOW	25070	JAUNE
*BLACK	25071	NOIR*
*BLUE	25072	BLEU*
RL. BLUE	25073	RL. BLEU
*GREY	25074	GRIS*
GREEN	25075	VERT
RUST	25078	ROUILLE
EX RED	25079	ROUGE

ACCO CANADA INC.
WILLOWDALE, ONTARIO

* INDICATES
75% RECYCLED
25% POST-
CONSUMER FIBRE

*SIGNIFIE 75 %
FIBRES RECYCLÉES,
25 % DÉCHETS DE
CONSOMMATION

BALANCE OF PRODUCTS
25% RECYCLED

AUTRES PRODUITS:
25 % FIBRES RECYCLÉES

ACCO® USA
WHEELING, ILLINOIS 60090
ITEM NO. 25074
MADE IN USA
0 50505 25074 5
LT. GRAY/GRIS/GRIS CLARO